# FEMORAL SLIDEWAY

## DESCRIPTION

The invention relates to a femoral slideway according to the precharacterizing clause of Claim 1 and to a femoral slideway / femur-size template arrangement and a knee endoprosthesis system with such a femoral slideway.

A femoral slideway of this kind is disclosed, for example, in the German patent DE 40 41 002 C2. In the surgical technique customarily used for knee-joint replacement by means of such a femoral slideway, an equal amount of bone is removed from the two condyles of the femur, so that the anterior or ventral cut is parallel to the posterior or dorsal cut. When the implant is in the position thus defined, the axis of rotation of the implant no longer coincides with the axis specified by the arrangement of the collateral ligaments, and this position is not anatomical inasmuch as when flexed, the implant is seated either too tightly on the medial side or too loosely on the lateral side.

The remedy that was recommended some time ago, namely an outward rotation of the cutting guide such that in the posterior region less bone is removed laterally than medially, whereas anterior-laterally more bone is removed than on the anterior-medial side, also presents disadvantages, which the construction of the femoral slideway proposed in DE 197 16 879 A1 of the applicant is

designed to eliminate. The crux of this solution is to rotate the anterior or ventral cut in the transverse plane.

However, this more recent solution also requires improvement with respect to optimizing the joint function in cooperation with the collateral ligaments in particular, especially in order to reduce the load imposed thereon.

It is thus the object of the invention to disclose a femoral slideway with further improved function, as well as a knee endoprosthesis system that can be efficiently constructed and employed and has such a femoral slideway as its essential element, and finally an advantageous arrangement comprising femoral slideway and femur-size template.

This object is achieved in its first, foremost aspect by a femoral slideway with the features given in Claim 1.

The invention includes the essential idea that it is advantageous to prepare for a knee-joint replacement by resecting more bone from the femur dorsally than is replaced by the implant (the femoral slideway). The "diminution" of the femoral slideway thus brought about in the dorsal region, in comparison to the original dimensions of the (resected) condyles or to a femoral slideway fitted in the conventional manner, produces an effective reduction of the turning radius of the tibial plate belonging to the prosthesis system and hence reduces the load on the collateral ligaments.

The decrease in the dimensions of the femoral slideway measured between the outermost, dorsoventrally opposed points on the condyle shell surfaces, in comparison to the previously customary dimensioning, is preferably in the

range between 2 and 5%. This is achieved by constructing the associated femoral slideway / femur-size template arrangement in such a way that the distance separating one or more pegs on the femoral slideway from its dorsal sliding surface is smaller by 5-15%, in particular by about 10%, than the corresponding distance by which bores in the femur-size template for positioning the pegs are separated from the contact surface that is to be apposed to the dorsal condyle surfaces of the femur.

The distance between the dorsal sliding surfaces and the one or more pegs on the inside of the femoral slideway is preferably in the range between 24 and 34 mm and in particular is 29 mm, the chosen value advantageously being kept constant in a knee endoprosthesis system for covering a relevant joint-size range.

Another distinguishing feature of the proposed femoral slideway is that particular dimensions maintain a largely constant relationship to one another, regardless of the size of the actual prosthesis. For instance, the ratio a:c between the maximal dorsoventral extent and the maximal lateral extent of the femoral slideway is about $0.9 \pm 0.02$. The patellar pit formed between the condyle shells preferably has a depth b, measured from the dorsalmost point on the condyle shells, such that its ratio b:a to the maximal dorsoventral extent of the femoral slideway is in the range between 0.4 and 0.5, in particular is 0.44.

The patellar pit is thus lengthened in the dorsal direction, as a result of which the patella can be supported over a large area throughout its entire functional range of flexion.

This elongation of the patellar pit, which furthermore increases in accordance with the anatomy in implants of

all sizes, allows for the fact that the patello-femoral contact surface in conventional femoral slideways has a relatively small bearing area. That is, in the region in which the patella leaves the trochlea and enters the intercondylar fossa, conventional femur components provide support only in the peripheral regions.

Furthermore, in the proposed femoral slideway the condyle shells are somewhat more strongly rounded in cross section (coronal section) than is the case in conventional femoral slideways. This modification was undertaken in the interest of improving the fit to the special tibia insert that belongs to a knee endoprosthesis system, but which is not within the scope of the invention.

The back surface of the femoral slideway, in one advantageous embodiment, bears a two-component Ti coating produced in a vacuum plasma procedure, consisting of a relatively thin, dense base layer and a severalfold thicker, open-pored cover layer. The dense base layer allows the femoral slideway, which for example consists of CoCrMo, to become completely sealed to the bone and, because it makes contact with the substrate over a large area, increases the stability of adhesion.

The open-pored and very rough surface of the cover layer provides ideal conditions for the growth of bony substance onto and into the carriage, producing a quasi "3-D interlocking" that can transmit pulling forces as well as pressure and transverse forces.

Additional advantages and useful features of the invention will be apparent from the subordinate claims and the following description of an exemplary embodiment with reference to the figures, wherein

Fig. 1 is a view (from proximal) of a femoral slideway according to one embodiment of the invention,

Fig. 2 shows the femoral slideway according to Fig. 1 in median section (sagittal section),

Fig. 3 is a plan view of an embodiment of a femur-size template,

Fig. 4 is a side view of the latter,

Figs. 5a, 5b show a conventional arrangement of a femoral slideway on a femur in comparison to an arrangement proposed here, and

Figs. 6a, 6b show scanning electron micrographs of a cross section of a conventional layered structure and of an embodiment of the layered structure proposed here for the back-surface coating of a femoral slideway.

In Figures 1 and 2 the femur component 10, called a femoral slideway, of a knee endoprosthesis is shown. The femoral slideway 10 comprises two convexly curved condyle shells 11, 12 and a patellar shield 13, which connects the two condyle shells 11, 12 rigidly to one another.

The condyle shells 11, 12 and the patellar shield 13 in their interiors define anterior and posterior fitting surfaces 14, 15 that correspond to a femoral ventral and dorsal cut, respectively, and are associated with a ventral and a dorsal saw-cut surface produced at the distal end of the femur when the latter was resected for fitting of the femoral slideway. The convex outer shape of the condyle shells 11, 12 specifies dorsal sliding surfaces 11a, 12a in the posterior region, over which the

corresponding surfaces of the tibia insert slide when the knee endoprosthesis is flexed. The patellar shield 13, which is recessed with respect to the convex outer surfaces of the condyle shells 11, 12, defines a so-called patellar pit 16, within which there is supported a patella component 17 of the knee endoprosthesis, which is indicated by a dashed outline in Fig. 2 and does not belong to the femoral slideway 10.

To assist anchoring and central placement of the femoral slideway 10 on the femur, on the inner surface of the femoral slideway two pegs 18, 19 are formed, the long axis of which is substantially parallel to the posterior fitting surface 15. These pegs project into holes in the femur, which have been drilled in the appropriate positions with the aid of a corresponding drilling template (see below), and this engagement gives the attachment of femoral slideway to bone greater stability than is provided by the fitting surfaces alone.

To ensure that the the femoral slideway will function optimally as a replacement for destroyed sliding surfaces on the femur, the construction must reflect as accurately as possible the anatomical arrangements and dimensions, but also within the scope of the invention includes a specific modification that will now be explained.

One of the relevant dimensions of the femoral slideway 10 is the maximal anterior-posterior or dorsoventral extent of the condyle shells 1, 12, a distance labelled a in Fig. 1. Another relevant dimension is the maximal lateral extent of the femoral slideway, i.e. the distance between the most lateral point on the lateral condyle shell 11 and the most medial point on the medial condyle shell 12, which in Fig. 1 is labelled c. Also significant is the distance from the outermost posterior point on the dorsal sliding surfaces 11a, 12a of the condyle shells 11, 12 to

the posterior bounding edge of the patellar shield 13, which in Fig. 1 is labelled b. A final significant distance is that between the outermost posterior points on the dorsal sliding surfaces 11a, 12a and the long axis of the pegs 18, 19 (which lie in one and the same coronal plane), labelled d in Fig. 2. In the exemplary embodiment described here, the ratio a:c is 0.9 and the ratio b:a is 0.44. On grounds of biomechanics and surgical technique, it has proved useful to make the distance d (between sliding surface and peg axis) uniform for all sizes of femoral slideway used in a knee endoprosthesis system. In the present case, this distance is 29 mm.

To determine the correct femoral slideway size, a femur-size template 20 shown in Figs. 3 and 4 is used. This comprises a basic part 21 with two flanks 22 and 23, each of which ends in a contact section 22a, 23a that is bent at a right angle and is apposed to the condyles of a femoral bone that is to be fitted with a femoral slideway (Figs. 1 and 2).

In the middle of the basic part 21 a measurement tongue 24, bent at an angle in two places, is mounted so that it can be displaced in a direction perpendicular to the plane in which the contact sections 22a, 23a lie. The measurement tongue 24 is marked with a scale 25, which indicates the maximal anterior-posterior extent of the head of the femur, i.e. the condyles, and thus indicates to the doctor the required size of the implant. In the basic part 21 of the femur-size template 20 two peg-hole bores 26, 27 are provided, which – in accordance with a supplementary drilling-template function of the femur-size template – assist the positioning of peg-holes in the femur so that they correspond to the pegs 18, 19 of the femoral slideway 10 as shown in Fig. 1. The axes of the peg-hole bores 26, 27 are separated by a distance e from the contact surfaces of the contact sections 22a, 23a.

This distance – along with the distance d between the sliding surfaces and pegs on the femoral slideway 10 itself (cf. Fig. 2) – is an additional relevant dimension in the concrete implementation of a knee endoprosthesis, for the following reason:

So that the above-mentioned peg-holes – which serve not only to position the implant but also to position the cutting guides used to produce the various saw cuts on the femur – can be drilled into the bone, drill bushes (not shown) are inserted into the peg-hole bores 26, 27.

It has proved advantageous, in particular from the viewpoint of reducing the load on the collateral ligaments during flexion of the artificial knee joint, to resect more bone dorsally on the femur than will be replaced there by the thickness of the dorsal parts of the condyle shells. For this reason the distance e is made larger than the corresponding distance d(Fig. 2). In the preferred embodiment the relative distance reduction, i.e. the quantity (e - d)/d, is about 10%.

The effect thus achieved can be seen in Fig. 5, where a sketch representing the conventional way of attaching a femoral slideway 10′ to a femur F′, shown in Fig. 5a, is compared with the representation in Fig. 5b of the arrangement proposed here. The anterior-posterior extent of the femoral slideway 10 in Fig. 5b, mounted on a femur F resected further in the dorsal region, is smaller by the amount (e - d) than in the conventional implant 10′.

Because the distance e is permanently specified by the femur-size template, which is used for all implants regardless of their size, and accordiing to what has been stated above the distance d in the embodiment of the femoral slideway is preferably kept constant for all implant sizes, the geometric relations will be slightly

different for implants of different sizes. This is acceptable, however, in view of the advantages for manufacture and manipulation that such a system brings.

Fig. 6b shows – in comparison to a conventional femur-carriage coating as shown in Fig. 6a – the appearance in the scanning electron microscope of a cross section through a two-component titanium-coating construction consisting of a dense base layer G, about 50 µm thick, and an open-pored cover layer D averaging about 250 µm thick, on a CoCrMo substrate S. Although the thickness and average roughness of the coating according to Fig. 6b, which is applied by a vacuum plasma process, are comparable to those of the known, sprayed-on coating according to Fig. 6a, it should be emphasized that the former has a more open-pored structure and a considerably reduced number of interface defects (indicated in both pictures by vertical arrows).

Implementation of the invention is not limited to the exemplary embodiment described above, but can also incorporate modifications, which in particular include departures from the specified dimensions and ratio values.

LIST OF REFERENCE NUMERALS

| | |
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| 10, 10' | Femoral slideway |
| 11, 12 | Condyle shells |
| 11a, 12a | Dorsal sliding surfaces |
| 13 | Patellar shield |
| 14 | Anterior fitting surface |
| 15 | Posterior fitting surface |
| 16 | Patellar pit |
| 17 | Patella component |
| 18, 19 | Peg |
| 20 | Femur-size template |
| 21 | Basic part |
| 22, 23 | Flanks |
| 22a, 23a | Contact sections |
| 24 | Measurement tongue |
| 25 | Scale markings |
| 26, 27 | Peg-hole bores |
| a, b, c, d, e | Distances |
| A-A | Plane of section |
| D | Cover layer |
| F, F' | Femur (shaped) |
| G | Base layer |
| S | Substrate |